SUCCESSFUL VWAP ALGORITHMS SHOULD INVOLVE DYNAMIC VOLUME PREDICTION AND OPTIMAL MARKET/LIMIT ORDER DISTRIBUTION.

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2 critical challenges for successful VWAP strategies

Execution of large orders at a favorable price without exposing the order to the market is a concern for institutional investors. The Volume Weighted Average Price (VWAP) is the most commonly used benchmark for this purpose. It is the average of the transaction prices weighted by the corresponding number of shares traded to daily total volume. Strategies that aims to track VWAP simply split the large order into smaller child orders to guarantee that average execution price of the order is close to VWAP.

Simple VWAP algorithms follow a static volume profile. Intraday stock volumes often follow a periodic profile, which are usually U-shaped. Namely, on average more transactions observed in the beginning and at the end of the trading day. See Figure 1 for the average volume profile of GARAN.

Algorithms that are based on such a static volume profile split the main order such that child orders are generated to have a profile similar to average volume profile. For example, historical averages show that 3.4% of the total daily volume of GARAN is traded during first 5 minutes of the first trading session. So, if a main order is to buy 1 million shares with VWAP benchmark, the algorithm executes 3.4% of the main order during first 5 minutes. The strategy follows this volume profile until the main order is fully executed. And in general, there is no optimization that divides child orders into market and limit orders.

Challenge 1: Successful VWAP algorithms should dynamically predict daily volume to adapt intraday volume irregularities. Although there is periodicity in the average intraday volume profile, significant deviations from the average profile might be observed (see Figure.1). Moreover, intraday volume irregularities mostly occur due to released information which creates a momentum regime or high volatility. Therefore, VWAP strategies assuming a static

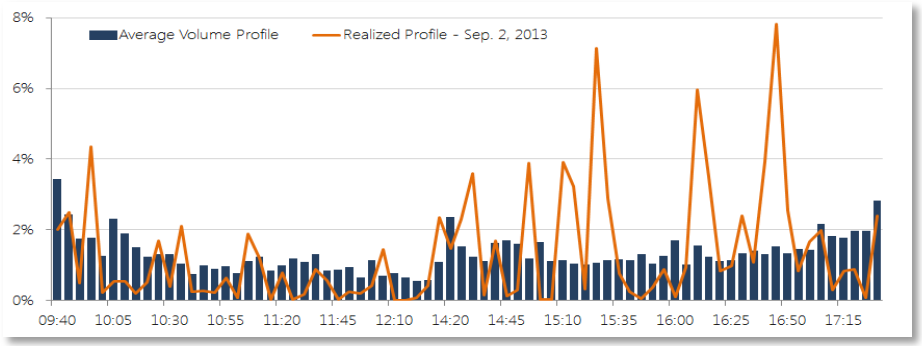

Figure 1 Average and realized (02.09.2013) volume profile of GARAN.

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profile might over or under trade at certain time intervals or price levels, which significantly deviates the execution price from the targeted VWAP.

Challenge 2: Successful VWAP algorithms should optimally distribute market and limit orders.
One of the main challenges of VWAP tracking is that the market volume consists of both buy and sell transactions at ask and bid levels, while the main order to be executed is one sided: buy or sell. To illustrate this case, let's assume a hypothetical case where the mid price (the average of bid and ask price) of a security is constant over the entire day. Note that the transactions would be both at the bid and ask prices, which would make the VWAP between the ask and bid price. If a VWAP strategy executes market orders only, in the case of buying, all the transactions will be at the ask price and the average execution price will be ask price, which is above the market VWAP (worse than VWAP). In the sell order case, the average execution price will be the bid price, which is below VWAP (worse than VWAP). This example shows that even the total market volume is predicted accurately, a VWAP strategy that uses market orders only would fall behind the VWAP price. Therefore, it is a must to have a mechanism which decides when and how many orders to send as limit orders.

Our adaptive VWAP algorithm uses intraday volume prediction model, as well as it optimally decides the proportion between market and limit orders.
To develop our VWAP tracking algorithm, we assessed two issues discussed. First of all, our daily volume prediction model updates the daily total volume prediction at the end of each one minute interval during the trading day. Based on the daily total volume prediction, the algorithm adjusts its trading speed or participation rate. Namely, we model the VWAP tracking algorithm as an adaptive participation algorithm.

Secondly, the child orders are divided into limit and market orders. To decide the proportion of market and limit orders, we use live limit order book and tick data to continuously calculate market profile, market order rates at the bid and ask levels of the order book. Then the algorithm finds the optimal order rates for market and limit orders subject to participation constraints. Limit orders which are not executed and far of the current mid price are cancelled or modified to increase execution probability.

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Request a live demo.
For detailed information about the GC algorithmic trading strategies and integration issues, or to request a live demo, please contact:

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Figure 2 Our VWAP execution and testing software.